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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 11.
B. T. GALLOWAY, Chief of Bureau.

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JOHNSON GRASS:

REPORT OF INVESTIGATIONS MADE DURING THE SEASON OF 1901.

BY

CARLETON R. BALL, Assistant Agrostologist.
GRASS AND FORAGE PLANT INVESTIGATIONS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1902.

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JOHNSON GRASS IN GRASS GARDEN ON GROUNDS OF UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 11.
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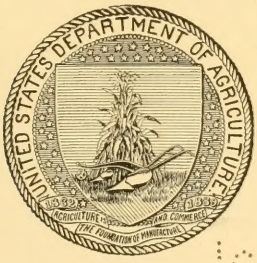

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., November 23, 1901.

Sir: I have the honor to transmit herewith a paper on Johnson Grass: Report of Investigations Made during the Season of 1901, by Carleton R. Ball, assistant agrostologist, Grass and Forage Plant Investigations, and recommend that it be published as Bulletin No. 11 of the Bureau series.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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PREFACE.

In June, 1901, Mr. C. R. Ball, assistant in the Office of the Agrostologist, was authorized and directed to proceed, under instructions from the Agrostologist of the Department, to points in Alabama, Louisiana, and Texas, for the purpose of making investigations concerning Johnson grass and to gather information for a report on this subject as required by law.[a] He was instructed to carefully study such methods as had been or are being pursued to exterminate this grass and to consult with the commissioner of agriculture of the State of Texas and with others as to plans for destroying Johnson grass where it had become a pest. He was further instructed to make arrangements for carrying on experiments along practical lines with the view of destroying the grass in an economical and effective manner. He was directed to examine carefully the laws of Texas relating to the subject in hand, to study the question of natural or artificial distribution, and, in fact, all points having a bearing upon the question of the value, harmfulness, and methods for destruction of this grass.

In regard to the means of eradication the whole field was carefully looked over and a piece of very badly infested land on the farm of Mr. John Parker, near the town of Taylor, Williamson County, Tex., was selected for the experiment. This selection was made under advisement with the Hon. Jefferson Johnson, State commissioner of agriculture and insurance, in cooperation with Prof. J. H. Connell, director of the Texas Agricultural Experiment Station. The results of the present season's investigations and experiments are presented in the report herewith submitted.

F. LAMSON-SCRIBNER,
Agrostologist.

OFFICE OF THE AGROSTOLOGIST,
Washington, D. C., November 23, 1901.

[a] House bill No. 121, Fifty-sixth Congress, first session, making appropriations for the Department of Agriculture.

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JOHNSON GRASS: REPORT OF INVESTIGATIONS MADE DURING THE SEASON OF 1901.

By Carleton R. Ball, *Assistant Agrostologist.*

JOHNSON GRASS (Andropogon halepensis (L.) Brot.)

DESCRIPTION.

A stout, erect perennial grass, with rather broad leaves and a large panicle which is open at flowering time. It produces great quantities of underground jointed stems known as rhizomes or rootstocks but popularly called "roots." It is closly related to the sorghums and resembles the ordinary sweet sorghum very much in its habit of growth, except that it is smaller and more slender. The ordinary height is about 5 or 6 feet, but in its ranker growth it sometimes reaches a height of fully 9 feet, with culms or stems nearly one-half inch in thickness at the base. It is a native of the Mediterranean region of Europe and Africa and also of southern Asia.

ORIGIN AND DISTRIBUTION.

Johnson grass was introduced into this country from Turkey about the year 1830—possibly a little later. It is said that Governor Means, of South Carolina, received a request from the Sultan of Turkey to send someone to the Ottoman Empire to instruct the Turks in the art of raising cotton. When the gentleman sent by Governor Means returned he brought with him from Turkey the seeds of a number of plants which were in cultivation there, and among them was the seed of the now famous Johnson grass. About the year 1840 Col. William Johnson, the owner of a large plantation at Marion Junction, near Selma, Ala., was on a visit to South Carolina, and on his return brought with him a quantity of Johnson grass seed which he sowed on his farm in the fertile bottom lands of the Alabama River. Colonel Johnson was the first planter to cultivate the grass in any great quantity and with great success, and it was from him that it received the name now most commonly used for it—Johnson grass. In South Carolina it was known as Means grass, from the name of the governor who was instrumental in its introduction, and that name is still used for it occasionally.

In later years it has been very frequently referred to under the name of Guinea grass, but that name should be restricted to *Panicum maximum*, a widely different plant. It has also been called by a great number of other names at different times and in different parts of the country. Among these names are Aleppo grass, Alabama Guinea grass, Arabian millet, Australian millet, Cuba grass, Egyptian grass, Egyptian millet, Evergreen millet, False Guinea grass, Green Valley grass, Morocco millet, St. Mary's grass, and Syrian grass. Some of these names have been given to it in different localities where it has been grown, while others have been given to it purposely by seed dealers in order to create a demand for the seed of a supposedly new grass. Many of these names refer to the places where it was supposed to have originated.

FIG. 1.—Johnson grass (*Andropogon halepensis*).

In the sixty years since it was introduced into Alabama, Johnson grass has continued its westward course until it is now found abundantly as far west as Texas, and in the river valleys and along irrigating ditches of New Mexico, Arizona, and California, extending along the coast region to Oregon and Washington. As a luxuriant and profitable growth, Johnson grass is confined in the Southern States to the fertile alluvial soils of the river bottoms and the black prairie region. It is also found in the poorer sandy or clayey soils of the hills and the pine barrens, but in such regions its growth is less vigorous. Above the latitude of 37°, or about that of Tennessee, it is much less frequent, because it is subject to winter killing during the more severe winters, although it may persist for several years as far north as latitude 42°, or that of central Iowa and New York. In the drier regions of the Southwest it is found in the greatest abundance along the irrigating

ditches, while on the Pacific coast it establishes itself very rapidly in the warm, moist, valley lands or in the drier parts along the canals of the irrigation systems.

DISSEMINATION.

When we stop to consider that in sixty years from the time Johnson grass was first cultivated in this country it has spread from the original point of introduction over more than half the United States, we realize that it must either have had especial assistance in order to cover so large a territory or is a plant remarkably well adapted to the conditions obtaining throughout this great area. As a matter of fact, both of these points are true. As the seed was introduced into Alabama for the purpose of cultivation, so it has been carried or sent from Alabama westward to a large number of Southern States. Persons recognizing its great value as a hay and pasture grass have been anxious to secure seed, and wherever they have established their meadows, there they have established a new center of infection for surrounding districts. It is quite probable that the introduction of this grass into most of the States which it now occupies to a greater or less extent was accomplished in just this manner by persons eager to grow this new and highly praised grass. In most of the Southern States it is probable that at one time or another seeds were planted in many places widely separated from each other. On the other hand, it seems almost certain that from the comparatively few centers of infection, which were thus purposely established, the seed had been unintentionally and constantly scattered until in most of the Gulf States this grass may be found on almost every plantation.

The principal and, in fact, almost the only means by which the plant is propagated is by the seed. This is produced in abundance, and is so well protected by the hard and firm coverings that it is enabled to withstand adverse climatic influences. One of the principal ways in which Johnson grass has been distributed so thoroughly is by means of the hay. It has been the custom of planters throughout almost the entire range of this grass to allow the seed to become ripe on the stem before cutting. The seed shatters very readily when ripe, and as the hay was hauled about the plantation to the points where it was to be fed or baled, and the baled hay carted about or carried on wagons to some shipping point, the ripe seed was scattered and an abundant stand of plants the next season was the inevitable result.

Cattle, horses, and other farm stock running at large have been very instrumental in scattering Johnson grass over the plantations. Wherever cattle are grazing on this grass after the seeds are formed large numbers of seeds are eaten. By reason of their hard outer covering the ripe seeds pass unharmed through the digestive tract of the animals and pass out of the body ready to produce a vigorous growth.

Wherever the droppings from such animals are found there is always danger of a growth of Johnson grass. In the same manner the manure from stock fed in the stables or yards will be filled with live seeds, and wherever this manure is scattered as a fertilizer in the fields the result is sure to be a crop of the grass.

The wind and several species of seed-eating birds also aid in scattering the seeds of this pest over the country, but the actual damage arising from this source is undoubtedly small. Floods also assist in the rapid and thorough dissemination of the seeds. As before remarked, Johnson grass is found most abundantly in the rich soil of river valleys. Every time these streams overflow their banks as a result of heavy rains, large quantities of seeds are carried downstream by the high water and scattered broadcast over plantations lying below.

One of the most common ways in which the seeds are scattered is through the medium of seed oats. It has been found quite difficult to separate the seed of Johnson grass from the oat seed, and as wherever oats are sown on land infected with Johnson grass ripe seeds of the latter are almost always harvested in the resulting oat crop, it will be seen how great the danger from this source really is. In this way the grass is carried not only from one plantation to another in the same neighborhood, but as the grain either for feed or seed is widely distributed the pest has been carried from one State or section to another. This has been especially true in the last few years.

The varieties of oats ordinarily raised in the South have been seriously injured year after year by rust. Recently strong efforts have been made to secure a variety which should be practically rust proof. Such a variety has been grown in the State of Texas and has been widely sold throughout the entire Gulf region under the name of Texas rust-proof oats. These oats were largely raised on land where Johnson grass was flourishing, and a large proportion of the grain contained the seed of Johnson grass. Wherever these oats have been sold Johnson grass has been introduced, and many plantations which had been kept scrupulously free from it for many years have been unwittingly seeded to this dreaded pest in this way. It has also been widely scattered along the rights of way of railroads. This has come to pass through the shipments of the baled hay from which the ripe seed has scattered along the track through the motion of the cars, and through the medium of stock cars in which this grass has been used for feed or for bedding the animals.

Johnson grass is also disseminated by means of the underground stems or rhizomes. Wherever a plant is started from seed these strong creeping rhizomes are thrust out and the patch grows slowly but steadily larger each succeeding year. Whenever a plow or other cultivating instrument passes through one of these patches fragments of the stems are frequently dragged for some distance and there

establish a new growth of the plant. Occasionally pieces of the stems become wedged in the hoofs of cattle crossing plowed fields and are carried for some distance before coming free again, and where they lodge a new center of infection is established.

CONTROL.

In the consideration which has just been given to the methods by which Johnson grass spreads so rapidly it was found that the ripe seed was the important factor in dissemination. The question of controlling this pest, then, resolves itself directly into the question of controlling the seed production of the grass. In short, the spreading of the grass would be almost completely checked if it were not allowed to produce seed. This may look like a very serious problem, and yet there is little doubt that nine-tenths or more of the Johnson grass which is allowed to mature seed is in cultivated fields or in other places where it is easily accessible and where seed production could be prevented. At the same time it should be remembered that it is in these most accessible fields and patches of the grass that ripened seed does the greatest damage. Except on the comparatively few large plantations where Johnson grass is grown as a hay crop and where its cultivation has been carried on successfully for many years, the utmost carelessness prevails in allowing the plants to mature seed. In a great many meadows which are devoted entirely to this crop thorough cultivation or plowing of the ground is given only at such long intervals that the grass becomes much weakened. Where this is the case the resulting crop is very irregular and uneven in its growth. Some plants will put forth flowers and ripen seed before others show any signs of doing so. The farmer who wishes to get the largest hay crop for his labor delays his mowing until the first seeds have ripened and fallen or are ripe enough to scatter from the hay after it is cut. This method of harvesting the crop should be avoided. The meadow should be so handled that the crop will be developed almost uniformly, as is the case with a crop of wheat or oats, and the cutting could then be so timed as to prevent the ripening of seeds on even the earliest of the plants. It has been noted, especially in the States of Louisiana and Texas, that even where a good, vigorous growth of Johnson grass was to be made into hay the whole field was allowed to ripen its seed before the cutting took place. This policy is not to be approved, because of the dangers arising from the great quantities of seed thus produced and because the hay is practically worthless for feed when cut at that period of its growth. This point, however, is discussed at greater length in another place.

Johnson grass growing along turn rows, fences, and roadsides should be mowed frequently to prevent the ripening of the seeds. In a great many instances, such as farms entirely inclosed by wire fences, a bunch

of cattle can be used and the grass thus kept grazed during the growing season. One State (Texas) has a law which deals with the seeding of Johnson grass on the rights of way of railroads. Such areas should be carefully looked after, and the production of seeds should not be allowed in any of the States where the grass is troublesome. There are, scattered about on pieces of land not in cultivation, small quantities of Johnson grass, and these are likely to ripen their seed unmolested unless they are grazed by cattle. The dangers arising from the scattering of seed from these struggling plants are, however, very small compared with those threatened by the wholesale production of seed permitted in cultivated fields and meadows. It is to be understood that this prevention of seeding is not recommended as a means for killing the grass, but simply to check its rapid spread to land heretofore unoccupied by it. No method of extermination is likely to prove successful so long as the area of infested ground is allowed to increase so rapidly from year to year. During the course of this investigation a large number of representative and intelligent planters in the different States visited were asked if, in their opinion, it was not true that nine-tenths of the spread of Johnson grass into places where it is not wanted was due to carelessness in allowing seed to ripen freely. In every case the answer was in the affirmative. The State of Texas alone among the States troubled by Johnson grass has enacted laws dealing with the question. Copies of these statutes are here given verbatim:

[H. B. No. 173, Twenty-fourth Texas legislature. 1895.]

AN ACT to make it a penal offense for any person in this State to unlawfully sow, scatter, or place on land not his own the seed or roots of Johnson grass or Russian thistles, or wilfully or knowingly sell or give away hay, straw, oats, or grain containing or intermixed with the seeds or roots of Johnson grass.

SECTION 1. *Be it enacted by the legislature of the State of Texas*, That if any person in this State shall knowingly, wilfully, and with intent to injure, sow, scatter, or place on any land not his own the seed or roots of Johnson grass or Russian thistle, or wilfully and knowingly sell or give away any oats, hay, straw, seed, or grain containing or intermixed with the seeds or roots of Johnson grass to anyone who is ignorant of the fact that such seeds or roots are so contained in or intermixed with such oats, hay, straw, seed, or grain, he shall be deemed guilty of a misdemeanor, and on conviction thereof he shall be punished by fine of not less than twenty-five dollars and not more than one thousand dollars.

SECTION 2. In prosecutions under the preceding article it shall not be necessary for the indictment to allege the name of the owner of the land, nor shall it be necessary for the State to prove the name of such owner, but it shall be sufficient to allege and prove that the land was not the property of the person accused.

SECTION 3. The near approach of the close of the session of the legislature, and the crowded condition of the calendar, and the fact that it is improbable that this bill can be read on three several days, create an emergency and imperative public necessity that the constitutional rule requiring bills to be read on three several days be suspended, and it is so enacted.

NOTE.—This bill became a law without the signature of the governor.

[H. B. No. 470, Twenty-seventh legislature of Texas. General Laws, Twenty-seventh Legislature, pp. 283–284. 1901.]

AN ACT to prohibit railroad and railway companies or corporations in this State from permitting Johnson grass or Russian thistles from going to seed upon their right of way, and fixing a penalty.

SECTION 1. *Be it enacted by the legislature of the State of Texas,* It shall hereafter be unlawful for any railroad or railway company or corporation doing business in this State to permit any Johnson grass or Russian thistle to mature or go to seed upon any right of way owned, leased, or controlled by such railroad or railway company or corporation in this State.

SECTION 2. If it shall appear upon the suit of any person owning, leasing, or controlling land contiguous to the right of way of any such railroad or railway company or corporation that said railroad or railway company or corporation has permitted any Johnson grass or Russian thistle to mature or go to seed upon their right of way, such person so suing shall recover from such railroad or railway company or corporation the sum of twenty-five dollars, and any such additional sum as he may have been damaged by reason of such railroad or railway company or corporation permitting Johnson grass or Russian thistle to mature or go to seed upon their right of way: *Provided,* Any owner of land or any person controlling land contiguous to the right of way of any such railroad or railway company who permits any Johnson grass or Russian thistle to mature or go to seed upon said land shall have no right to recover from such railroad or railway company as provided for in this act.

NOTE.—This act took effect April 9, 1901, thirty days after adjournment.

The provisions of these laws are excellent, in spirit at least, but as with most other preventive and remedial legislation, their successful enforcement depends largely upon a strong public sentiment of approval. Until this sentiment is thoroughly aroused such laws are apt to be dead letters. This fact becomes strongly evident when one takes into consideration the large number of planters who cry out against this nuisance and yet are engaged in the raising of oats badly infected with Johnson grass. The mixed seeds of the two are largely sold in other States as pure seed oats in spite of legislation to the contrary.

ERADICATION.

A large number of planters who own land infested with Johnson grass are firm in the belief that it can not be killed under any circumstances or by any methods. This may have been true in their own experience, and yet it is to be regretted that when the possibilities of ridding the land of this grass have been fully proved so many allow their prejudice to prevent their achieving similar desirable results. They are convinced that it can not be done, and so refuse to accept these evidences of successful work or to try it for themselves. There is no one method which can be recommended as certain to be successful under all conditions. Within the area of the United States now infested with Johnson grass there is too wide a variation in the conditions of heat and moisture and character of soil to allow of unvarying times and methods of culture. Therefore, in any method much must depend on the good judgment of the cultivator. There is no doubt,

however, that fields have been entirely freed from this pest. Instances have been found in almost every community. They are most common in those States where Johnson grass has been longest known and where the planters have become most familiar with it. In some cases these good results have been obtained under field conditions; in others successful results have been obtained where only small patches were concerned. In this latter case the means used would often not be practicable or economical if the work required was on a large scale. A very large number of methods for destroying Johnson grass have been advocated at different times and places. Many of these are worthless, having been advocated by those not very familiar with the plant, in its serious aspect, as a menace to crops. The conditions necessary to the destruction of this grass are simple, but to fulfill them all is a very difficult matter. To entirely rid a piece of land of Johnson grass requires that every seed and plant be destroyed. The seeds in or on the soil must be made to germinate and the young plants killed; all the old plants must be destroyed, and the complex "root" system must be either killed or so discouraged that it will cease to send up green sprouts, and so finally starve to death. There are perhaps three general methods by which it is possible to accomplish these results. The first is by hand labor; the second by field cultivation; the third by the use of chemical substances. The first and second methods are frequently combined.

HAND LABOR.

Hand labor is naturally slow, expensive, and utterly impossible on large areas. For small patches scattered about in fields or gardens or in situations where teams and machinery can not be used to destroy them, hand labor is most economical, having also the advantage of being usually more thorough and less dependent on external conditions than any other method. The plants are uprooted and all the stems to the last fragment removed from the soil, all being hauled away and burned to prevent their taking root again and doing further damage. The great difficulty of this method lies in reaching the depth necessary to find all the stems, and it is also always uncertain that every one of the small fragments has been removed from the soil; but both must be done before there can be any assurance that the spot is free from danger of a new crop. The question of hand labor as a factor in destroying this grass will be considered in connection with certain patent methods.

CULTIVATION.

When it is desired to destroy Johnson grass by cultivation, there are a variety of methods that may be employed. The land may be fallowed in summer or in winter, or it may be worked in some crop.

A combination of two of these may be used. The purpose of cultivating in summer fallow is to expose the underground stems to the heat of the sun; that of cultivating in the winter fallow to expose them to the action of frosts.

WINTER FALLOW.

The method of winter fallowing the land and frost killing the grass can be used in only a small part of the large Johnson grass region. The grass does not usually become very troublesome where the climate is cold enough to allow of killing the exposed stems by frost. There is, however, a considerable area in the northern part of the Johnson grass belt where this method will be quite successful in the average winter. The performance is quite simple and very effective. The field is plowed up in the late autumn to a depth of about 3 or 4, or even 5, inches, depending on the amount of frost that may be expected. This soil is left exposed until the stems in the turned portion have been killed by the cold. The ground should then be plowed again, preferably crosswise to the first plowing. The second plowing should go to a greater depth than the first, in order to turn up a new layer of fresh, uninjured stems. By plowing crosswise the second time any stems left deeply covered in the turned soil at the first plowing are more apt to be exposed, while any cutting and covering done during the first operation would be unfailingly remedied by the second. Ordinarily two plowings would be sufficient for the purpose. No doubt some pieces of stems will survive even this treatment. Where the number is small and the patches scattered, it is best to dig them out by hand during the growing season.

SUMMER FALLOW.

The most uniformly successful method of destroying the grass is that of summer plowing fallow land. The field may be sown in the fall to some grain crop, to be taken off in the late spring. If the land is a meadow, one cutting of hay may be secured before the time for the destruction of the grass. The best time to commence the process of eradication varies. It must be done during the six weeks or two months when the longest period of hot, dry weather may be expected. This will be between the last of June and the first of September ordinarily. It may, however, commence as early as June 1, or even in May, as was the case the past summer. If the grass is growing vigorously at the time the plowing is begun, the more surely will it be killed by the disturbance and exposure of its stems. If it is in a resting condition, any cultivation during the growing season will serve only to promote a more rapid growth unless the grass has been greatly weakened by previous unfavorable conditions.

At the first plowing the soil should be turned to a depth of 2 or 3

inches or a little more. This will depend upon the mechanical condition of the soil and the quantity of stems present in it. If the soil is loose and open and the quantity of stems in it is not great enough to form a compact sod, the land may be safely turned to a depth of over 3 inches. If, however, the land is of a firm and tenacious character, turning up in clods or sods, or if the stems are abundant enough to produce this effect, the plowing should be shallower. In any case the soil turned over must not be deeper than the sun will penetrate with killing power; otherwise that portion of the stems buried most deeply by the turning will remain uninjured and will be stimulated to vigorous growth. This renders the labor of destruction more difficult than if a shallower stratum had been turned and all the stems included in it killed by the heat. In some cases it may be desirable to use a disk or acme harrow on the land immediately after the first plowing, both in order to level the surface if it be clodded and to expose more of the disturbed stems than would otherwise be done. The field should then be allowed to remain undisturbed until the sun has had time to do its effective work and until a new growth has appeared from that portion of the stems below the level of the first plowing.

When this growth has reached a height of about 5 inches, showing that the living rhizomes are again vigorous, the second plowing should be given. This should be done crosswise of the field, or at right angles to the first plowing, in order to certainly remedy any cutting and covering done during the first plowing. The second plowing should be about 2 inches deeper than the first if possible. This also will vary with the condition of the soil and the depth of the first plowing. The idea is to turn up a fresh layer of the underground stems to the action of the sun, and the same requirements as to the thickness of the layer of fresh stems thus turned should be observed.

The success of this method of summer killing will be seen to depend very largely upon the length of time during which dry, hot weather is maintained. If a period of rain should set in after the first plowing has been done and before the stems exposed by the plowing are dead their vigor will be increased and the length of time necessary to kill them will be thus extended. In that event as many as three plowings might be necessary in order to complete the work of destruction. However, in most of the Johnson grass belt several weeks of fairly hot and dry weather may be confidently looked for during the summer.

Where the soil is not too hard or lumpy a spring-toothed harrow may be used to drag the stems from the soil after plowing. They can then be collected and burned. Even under the most favorable conditions it is probable that some stems will escape destruction and produce new growth when the rains commence. The importance of completely ridding the field of the grass can not be too strongly urged. The small scattered patches do not at first appear troublesome or dan-

gerous, and too often they are neglected and allowed to quickly reseed the whole field. A comparatively small amount of labor will clear them out to the last stems, and the desired result will thus be secured. If this is not done the good results of the repeated plowings are lost and the field is soon as bad as ever.

CULTIVATION IN CROPS.

Many planters have testified that they have cleared their fields of Johnson grass without interrupting the ordinary system of cropping. In some instances this has been done in a single season. In others it has been accomplished only in from three to five years of labor. The crop raised is usually cotton, and the method always involves a large amount of hand labor. This method is expensive, and yet where it can be practiced the more thorough cultivation thus given is repaid by the increased yield of the crop. To be successful it must be entered into in no half-hearted way, as it always demands careful work and unrelaxed vigilance. At every plowing or cultivating of the land the stems exposed on the surface are removed from the field and destroyed. Plants persisting in the rows are dug out and destroyed when the crop is hoed, and this constant warfare is repeated month after month and year after year, if necessary, until the land is free.

PATENTED METHODS.

A Texas company has patented a cultural method of killing the grass. This method has been widely advertised and has been the subject of several inquiries received by this office from Texas planters. For these reasons a thorough investigation of the method was made.

The process of this company is as follows: The ground is broken to a depth of about 3 inches some time during the winter. The broken ground is then pulverized with a harrow as deep as it was broken, for the purpose of breaking up the rootstocks and stimulating an early and vigorous growth of the grass in the spring. The grass is then allowed to grow undisturbed until about the middle of April, when the land is again broken and the green grass turned under. About one week after this second breaking the ground is again pulverized as deeply as plowed. The land, whether allowed to remain fallow or planted in cotton, is then cultivated from five to eight times during the season. The intervals between the cultivations extend from a week to twenty days, depending upon the growth of the grass, which should be allowed to make a good, vigorous start between cultivations. Each cultivation should be made as deep as the land is mellow, which should be 6 or 8 inches after several cultivations, the purpose being to stimulate the grass to the greatest possible growth, and by never allowing it to reach any considerable height its vitality will finally be exhausted and it will thus be killed.

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If this method is used on fallow land it will be seen that a much greater amount of work is required than would be necessary by the process of summer cultivation outlined above. It is also required that the work be done during the spring and early summer when planters are usually very busy. If, instead, the land be cultivated in a cotton crop during these operations the fact that the land can be broken or cultivated in but one direction only renders the labor much more difficult. The plants which are growing in the cotton row are untouched by the frequent deep cultivations and continue their growth unchecked. In order to exterminate the plants the slow and expensive method of digging them out by hand must be employed. If successfully done this method also endangers the life of the young cotton plants. The principles on which this method of extermination are based are doubtless sound, but the successful working out of the method is always expensive. For this reason it is not likely to be adopted by any of the numerous renters who make up a large proportion of the agricultural population in all the Southern States. It must also be remembered that since this method has been patented it can not be used by any planter except by the consent and under the direction of the patentee. The charge made by this company for directing their methods during the past season was $2 per acre. In return they guaranteed that if directions were implicitly followed the grass would be exterminated. There is no doubt that the same amount of labor expended during the late hot summer could be much more cheaply performed and would be equally successful. The payment of the bonus of $2 per acre would not be required and the planter would take advantage of a season when his growing crops did not demand all his attention.

USE OF CHEMICALS.

A variety of chemical substances have been employed for destroying Johnson grass. Among these are salt, kerosene, lime, bleaching powder, and some more complex mixtures, such as nitrate of soda and white arsenic or arsenious acid in water. A certain proportion of these last-named chemicals has been patented for this purpose.

Common salt has frequently been used by planters for killing this grass. It is generally applied broadcast, but is sometimes used as a brine. So far as known, it has never been used on any large fields of the grass, but commonly only on small patches, in gardens, etc. The effect of salt, when used in definitely known quantities, has not been determined, because on the small patches no record is usually kept of the amount actually used or of the size of the patch. It is quite certain that in such cases a larger amount per acre is used than could be profitably applied in large areas. There is also considerable uncertainty as to the actual value of salt in any quantity. Some planters have reported that when applied in a layer 2 inches deep on the surface of

the ground the grass was killed. Others report results directly opposite. Wherever it is applied in the dry form there is always danger of much of it being washed away if the first succeeding rain happens to be heavy. The effect of salt upon the roots beneath the surface is entirely lost unless it is carried into the ground. It can not be recommended as an effective agent for field use.

Kerosene has been used in about the same way as salt. Its value as a destroying agent is doubtful. Mr. David Williams, of Washington, Tex., reported using about 1 gallon on a patch 6 feet square with perfect success. No Johnson grass appeared in the two years following. The oil used in this case was probably refined oil, which is expensive. Since the discovery and opening of the great oil fields in southern Texas, crude oil can be secured at a much lower rate than the refined article, and it would probably be quite as effective for killing vegetable growth as the refined oil. It would, however, be much more difficult to apply the crude oil on account of its thicker consistency, but for this same reason it would not be as easily washed from the soil.

Chloride of lime or bleaching powder has also been recommended for this use, but its value has not been definitely proved. The solution of white arsenic and nitrate of soda, referred to above, was patented in 1898 by Mr. William A. Chapman, of Cleburne, Tex., and is made and used in the following manner: One pound of white arsenic is introduced into 6 gallons of water and boiled until the arsenic is dissolved. The mixture is then completely cooled and 1 pound of nitrate of soda is dissolved in it. The addition of the nitrate of soda is for the purpose of holding the arsenic in solution, as otherwise it would recrystallize in the water and a repeated boiling would be necessary each time it was desired to use the solution. The poisonous element is the arsenic. It is intended to apply this liquid with a sprinkling pot, and one or perhaps two applications are recommended. No further information as to this patent compound has been secured.

ELECTRICITY.

Electricity has frequently been advocated as a sure method for eradicating all vegetable pests. A few years ago it was reported that a company was being organized in Fresno, Cal., to utilize this method, but nothing further has been heard of it. Electricity can not be satisfactorily and economically used until different and less expensive methods of applying it are discovered.

UTILIZATION OF JOHNSON GRASS.

So great an evil has Johnson grass become in the grain fields and cotton plantations that many planters and others have become violently

prejudiced against it. They refuse even to listen to the suggestion that it makes a valuable and nutritious hay, and wish to hear of nothing but its complete and rapid extermination. Nevertheless, the fact remains that in the States of Georgia, Alabama, and Mississippi, where the grass has been long established, many hay farms of several hundred acres each now exist and have existed for years. On some of these, as for instance those in the Alabama Valley in the vicinity of Montgomery and Selma, or in the famous Delta of Mississippi near the Yazoo River, the production of Johnson-grass hay has been found very profitable on lands which rarely produce less than a bale or a bale and a half of cotton per acre. Of course, on these rich lands the yield per cutting and the number of cuttings obtained in a single season will, as a general rule, be greater than on poorer soils. At the same time, the profit from any crop is less on poorer soils than on the richer, so that under these conditions Johnson grass at the prices of hay for the past few years is a profitable hay crop throughout the Southern States. It has advantages over several of the commercial crops which can be raised in those States. In the first place, a meadow can be very easily set in Johnson grass if that be desirable. On many plantations, however, good meadows, or what would quickly make good meadows if permitted, have already been formed, and the growth is vigorous, luxuriant, and long continued. The yield is large, and the quality of the hay when cut at the proper time is not exceeded by any other hay on the market, although this may sound like a strong statement. Of course, Bermuda hay is finer and probably yields more food, ton for ton, but the yield per acre is not usually as large, while the labor of cutting and curing is greater, and the hay is so fine that considerable of it is wasted in feeding. In most markets where Johnson-grass hay comes into competition with other hays it does not sell for as high a price, it is true, but this is due to several causes, chief among which is probably the fact that the hay has not been of first quality because of having been allowed to become mature and woody before cutting. There is also a strong prejudice against it, because so much of it contains ripe seed which the users are afraid of introducing into fields.

There have been many inquiries concerning the nutritive value of Johnson grass, and two tables of chemical analyses are given to show this value. Table I, adapted from Bulletin No. 20 of the Texas Agricultural Experiment Station, shows the composition of the grass at different stages of growth. The amount of water is first calculated and then the percentage of the ingredients in the dry material. The carbohydrates and albuminoids of this table are the same as the nitrogen-free extract and the protein, respectively, of the second table. The total nitrogen given in the third line from the bottom is the amount

of that substance in the albuminoids or protein, and is the sum of the albuminoid and amid nitrogen given in the last two lines of the table.

TABLE I.

	Time when cut and state of growth.					
	April 2—6 inches high.	April 10—8 to 10 inches high.	April 21—12 to 18 inches high.	April 29—18 to 30 inches high.	May 7—seed in dough state.	May 18—seed mature.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Water	81.06	77.44	86.09	80.9	76.5	69.33
Ash	11.24	11.62	11.68	10.38	7.98	6.36
Ether extracts (fats)[a]	5.59	8.60	8.10	6.52	4.11	4.07
Crude fiber	21.55	18.74	24.56	25.29	33.32	33.66
Carbohydrates	46.2	41.5	32.41	43.75	45.15	46.10
Albuminoids	15.42	19.54	23.25	14.06	9.44	9.81
Total nitrogen	2.78	3.12	3.73	2.25	1.51	1.57
Albuminoid nitrogen	2.55	2.72	2.73	1.96	1.34	1.40
Amid nitrogen	.23	.40	1.00	.29	.17	.17

[a] The ether extract in this and in the analyses of the other grasses, especially in the younger plants, represents more than the true fats, owing to the large amount of coloring matter removed.

It should be remembered that only a large series of analyses at different stages can show conclusively at what period the grass has the highest nutritive value. This may differ from the time when it has the highest feeding value to the farmer. To him the time when the grass gives the largest yield must also be taken into consideration. This may not be exactly the time when its nutritive value is highest. The time for cutting Johnson grass, as above stated, is when just in flower or a little earlier than the "dough" stage of Table I. It will be noted that the percentage of water and ash or mineral matter in the table gradually decreases as the plant gets older. The carbohydrates are about the same at both ends of the test. The valuable albuminoid or muscle-making material is greatest when the plant was 12 to 18 inches high, after which it decreases rapidly, while the crude fiber increases with the age of the grass. From this table Johnson grass would appear to have the greatest nutritive value when about 20 inches high or perhaps a little more, but of course the yield at this period would be considerably less than when the grass is in flower. Larger series of analyses would be very helpful in more accurately determining just when the grass should be cut.

Table II contains comparative analyses of timothy, redtop, Johnson grass, and red clover hays. The figures for timothy are the average of 68 analyses; for redtop, the average of 9 analyses; for red clover, 38 analyses; and for Johnson grass, 3 analyses of air-dried hay and 7 analyses of the water-free substance.

TABLE II.

Kind of forage.	Fresh or air-dry substance.						Water-free substance.				
	Water.	Ash.	Crude protein.	Fiber.	Nitrogen-free extract.	Ether extract.	Ash.	Crude protein.	Fiber.	Nitrogen-free extract.	Ether extract.
Timothy hay	13.2	4.4	5.9	29.0	45.0	2.5	5.1	6.8	33.5	51.7	2.9
Redtop hay	8.9	5.2	7.9	28.6	47.4	1.9	5.7	8.7	31.4	52.1	2.1
Johnson grass hay	10.30	6.77	7.30	29.34	44.12	2.16	6.62	6.44	34.22	50.89	1.96
Red clover hay	15.3	6.2	12.3	24.8	38.1	3.3	7.3	14.5	29.1	45.2	3.9

From this table we see that an analysis of three samples of Johnson grass shows it to contain very nearly as much protein as redtop hay, and considerably more than timothy hay, the figures being 7.3 per cent, 7.9 per cent, and 5.9 per cent, respectively. None of them contain as much as the rich red clover. In the water-free substance, however, the Johnson grass shows a little less protein than either of the other grasses; in fat, too, it averages a little lower. The amounts of fiber and nitrogen-free extract do not differ enough from those of timothy and redtop to deserve special mention. When we consider that Johnson grass yields much heavier than either timothy or redtop, and that it is nearly equal to these in feeding value, we realize that it is an exceedingly valuable hay grass for the Southern States.

It must not be forgotten that in order to properly produce this hay intelligent care and cultivation of the meadow is necessary. Any idea that a meadow once set may be cropped indefinitely without further treatment must be abandoned at once. To secure the best results, both in quality and quantity of forage, the meadow should be broken up at least every second year. If this thorough plowing is delayed longer than the third year the growth of the grass is greatly weakened by the crowding of the growing rootstocks or underground stems and the consequent checking of the growth of the grass. The meadow should be given a thorough plowing to a depth of several inches, and the land should then be harrowed until smooth in order to present a good surface for mowing. There need be no fear of destroying the meadow if this plowing is done in the spring, or in the fall where there is little danger from winter frosts. The vigor of the plants is greatly increased by this thorough breaking up of the matted stems, and the following crop will be even and luxuriant in growth.

The grass should be cut when the flower heads have begun to open. If cut at this time the hay made from it will be of the finest quality and there will be no danger from ripened seed. The yield may not be quite as large per acre, but the quality will be better, and the grass will renew its growth more rapidly.

Some of the most successful planters in the Johnson grass region

make a practice of sowing some other crop on the meadow when they break it up. Oats may be sown, and an early spring crop of good oat hay be thus secured. This crop will contain some Johnson grass, but not much. The second cutting will be earlier if following an oat crop than if the grass be allowed to grow alone. Another practice which serves two good purposes is the sowing of cowpeas in the Johnson grass meadow when it is broken. This may be done at any time during the spring or early summer. The cowpeas will not only furnish excellent hay, which combines well with the Johnson grass hay as a feeding ration, but, as is well known, they also help to restore the fertility of the soil. Such a sowing is therefore especially desirable wherever meadows are established on the poorer soils. If the growth of Johnson grass is more rapid than that of the pea vines, and there is danger of the latter being choked out by the vigorous grass, the mowers should be run over the meadow with the bar raised high enough to cut the tops of the Johnson grass without injuring the pea vines.

Johnson grass is not of especial value as a pasture grass. Its growth does not begin until rather late in the spring and does not last after the first heavy frost of autumn. Throughout its range, however, it is grazed to quite a large extent during the summer and affords an abundant and nutritious pasturage. This is especially true in moist or irrigated soils where its summer growth is not checked by drought. All kinds of farm stock graze it well and thrive upon it. There is a rather widely prevalent idea that it can be killed by pasturing. The growth of the grass is much checked and weakened by close pasturing, especially if continued for several years in succession. This is due not so much to trampling and grazing as to the close crowding and matting of the stems in the soil, thus literally choking the grass out. The remedy for this is to break up the land every third or fourth year, thus giving the stems a new and vigorous impulse to growth.

A few cases of cattle having been poisoned by grazing Johnson grass have been reported. These reports have been noted only through the papers, none having been made directly to this Department. Authentic details are rarely given in such cases, and very little weight can be given to these rumors. Since Johnson grass is closely related to sorghum, which is known to be poisonous under some circumstances, it would not be surprising if Johnson grass should also be poisonous under like conditions. Investigations have been conducted for several years to determine the cause of sorghum poisoning, but as yet without conclusive results. Neither sorghum nor Johnson grass is likely to be abandoned as a stock food, however, because of the infrequent danger from poisoning. In comparison with the great number of cattle fed or pastured on Johnson grass the reported cases of poisoning are extremely rare.

SUMMARY.

Johnson grass is a tall, vigorous grass, closely related to the sorghums, with a very strong system of long, jointed, underground stems, popularly known as roots. Each joint of this underground stem is capable of producing a new plant.

It is a native of the tropics of the Old World, and was first introduced into this country as a hay grass in South Carolina about sixty years ago.

It has spread rapidly throughout the entire south to the Pacific coast and thence north to British Columbia. It thrives best in rich, moist, alluvial or irrigated soil, where it is also most difficult to eradicate.

It is commonly spread by means of its seeds. They are widely scattered from hay cut after the seed has matured, and are often planted with seed oats. The seeds are unharmed by passing through the digestive tract of animals, and are thus widely scattered in manure.

The grass should never be allowed to ripen its seeds in meadows, fields, or along roads, fences, or railways.

It can be destroyed by hand labor—digging out the underground stems.

Under field conditions it is best killed by plowing fallow land during hot, dry weather. The stems are thus exposed to the heat of the sun and soon killed. The same result follows the action of severe frosts.

It can also be killed during the cultivation of a cotton crop by much extra hand labor.

Various chemical substances have been tried but none have thus far proved successful and economical.

Johnson grass makes a very good quality of hay when cut while just in flower, and it may be profitably cultivated throughout the South for this purpose. Meadows should be broken up at least every third year to loosen the matted stems. It is not necessary to reseed meadows when thus treated.

Cow peas may be sown in the grass when it is broken in the spring. When broken in the fall, oats may be used with it. It affords good pasture during summer when treated in the same way as meadows.

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